

Terrestrial Planet Finder Mission

TPF

A NASA  
Origins  
Mission

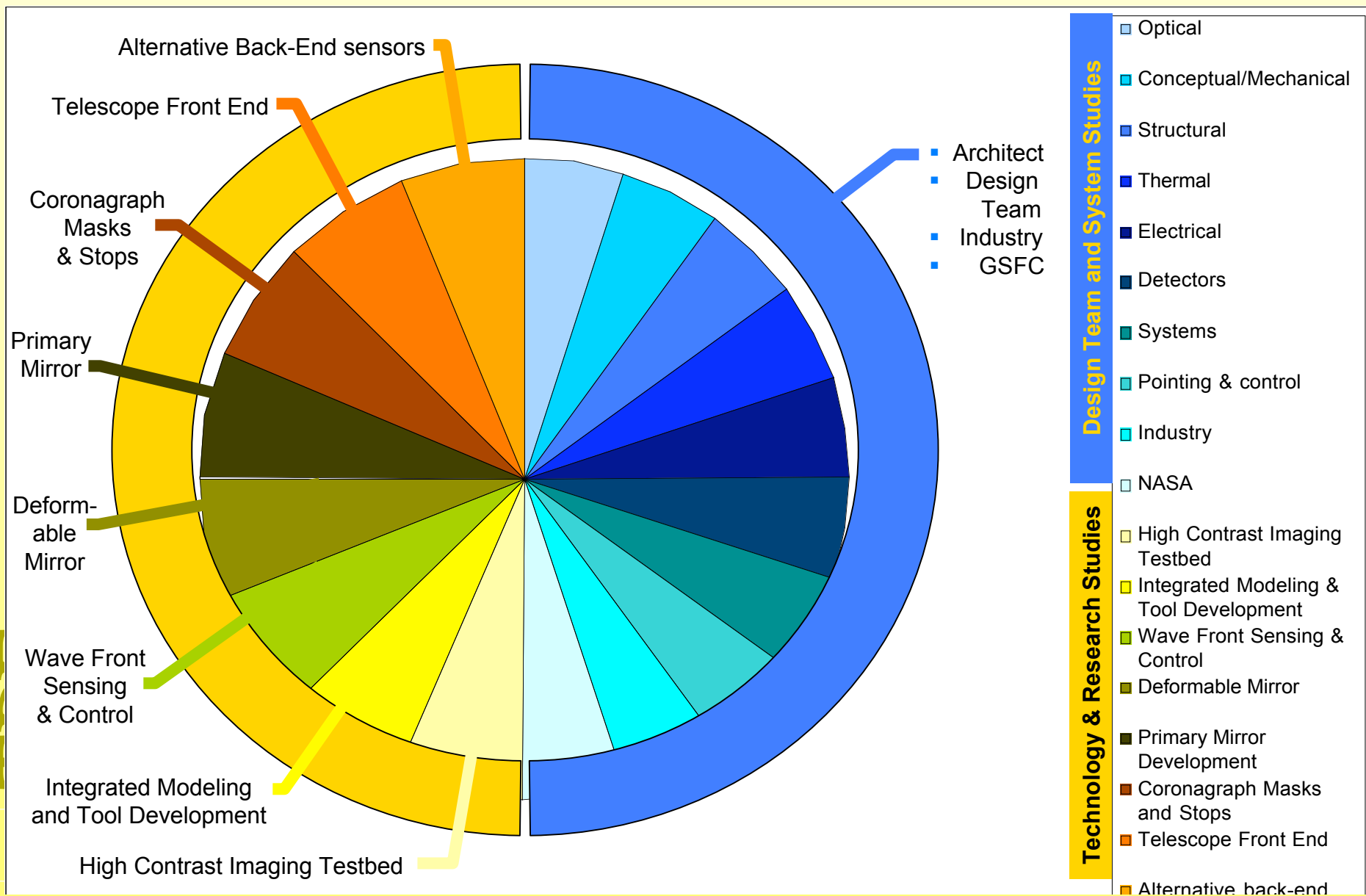
# Overview

## Terrestrial Planet Finder Coronagraph System Studies

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TPF Coronagraph  
System Manager

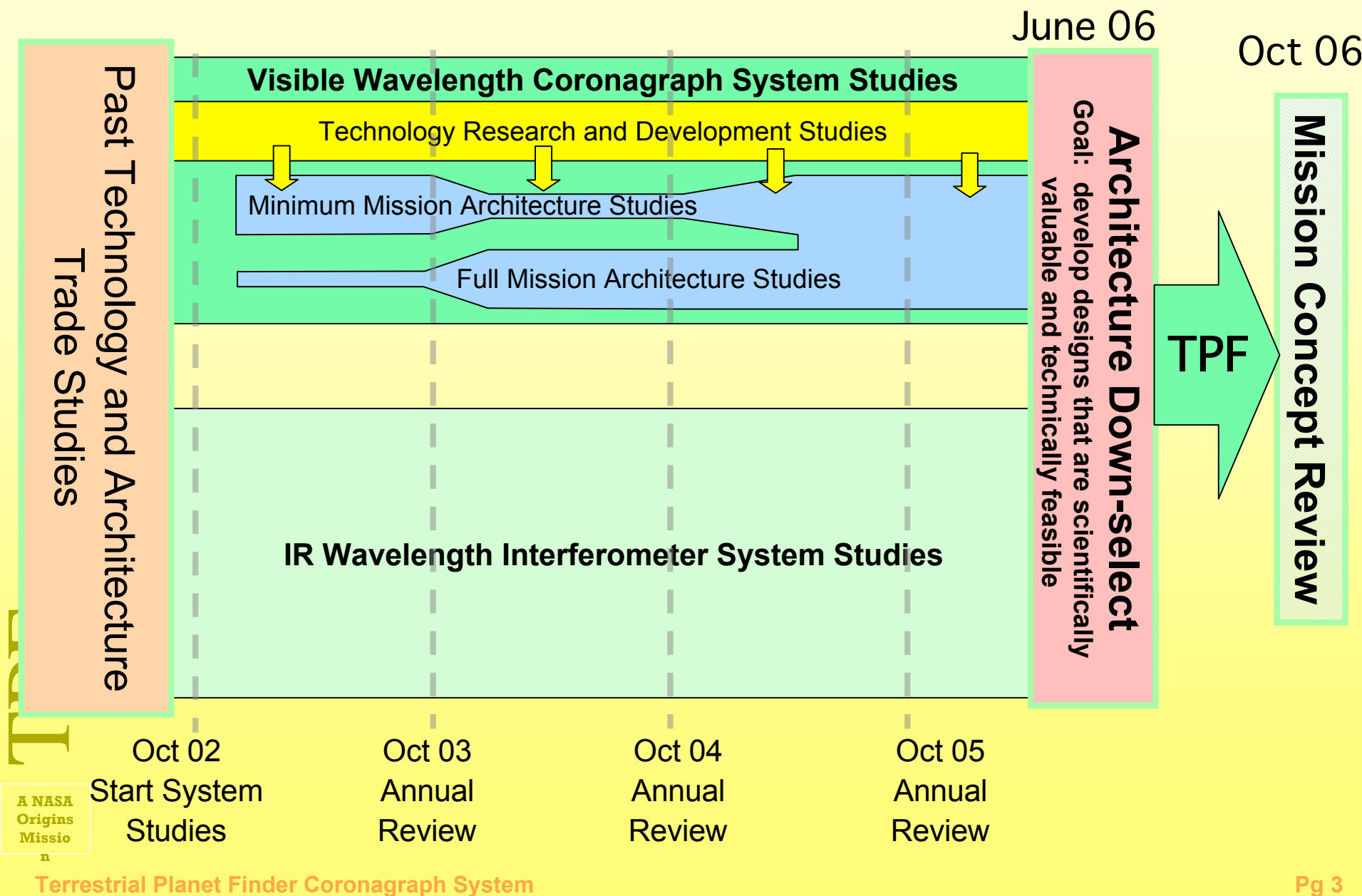


# TPF Coronagraph System Studies





# TPF Architecture Studies





# Coronagraph Background



- History

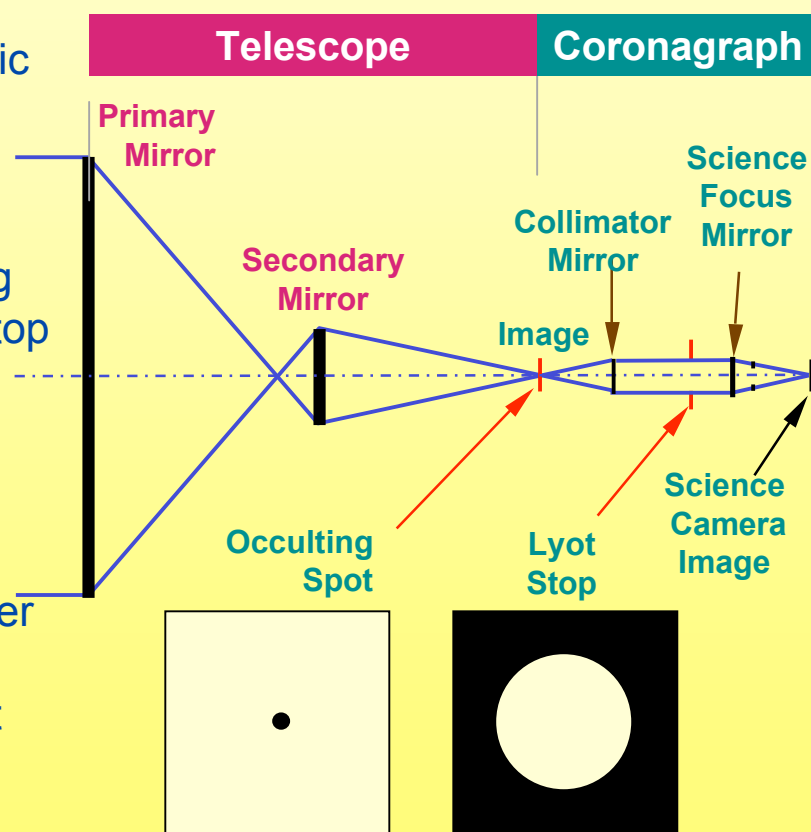
- ~1850: Astronomers started trying to create an instrument that would block sunlight to study the sun's corona
- 1932: Astronomer Bertrand Lyot built 1<sup>st</sup> working coronagraph

## Lyot's contribution:

- Stray sunlight, diffraction scatter, & atmospheric effects overwhelming the corona
  - » On the top of a mountain, very smooth optics
- Diffraction from the telescope aperture and occulting mask can be controlled by collimating the light, adding occulting mask & diffraction stop
  - » equivalent to a mathematical Fourier transform
  - » Kicks diffracted light out to the edges of the field where it can be blocked with a Lyot stop

## TPF Coronagraph Challenge:

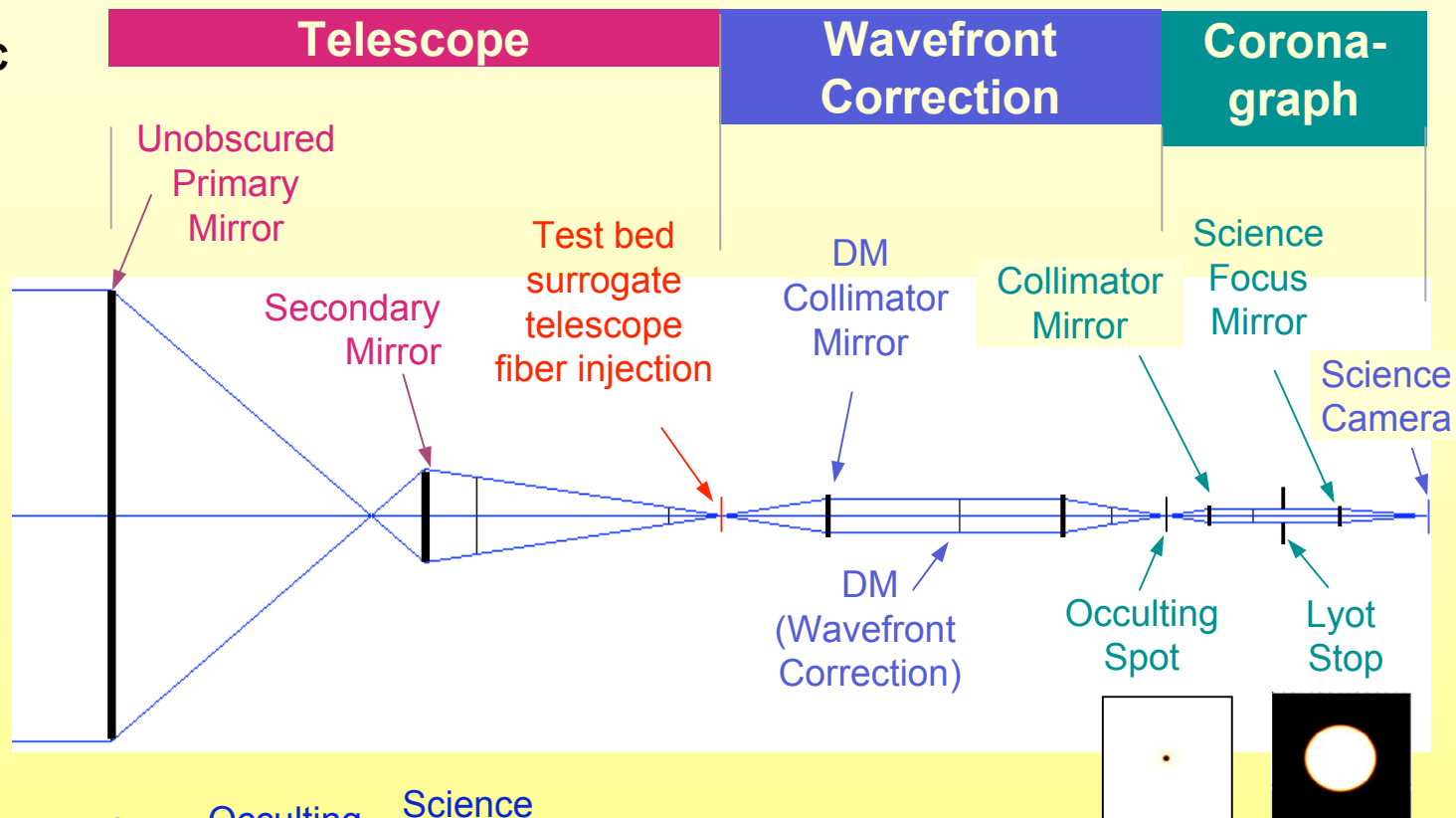
- Same problem with stray light, diffraction scatter and environmental effects – star light easily overwhelms an earth-like planet -  $10^{10}$  contrast
- Use WFS&C, advanced technology to reach solution



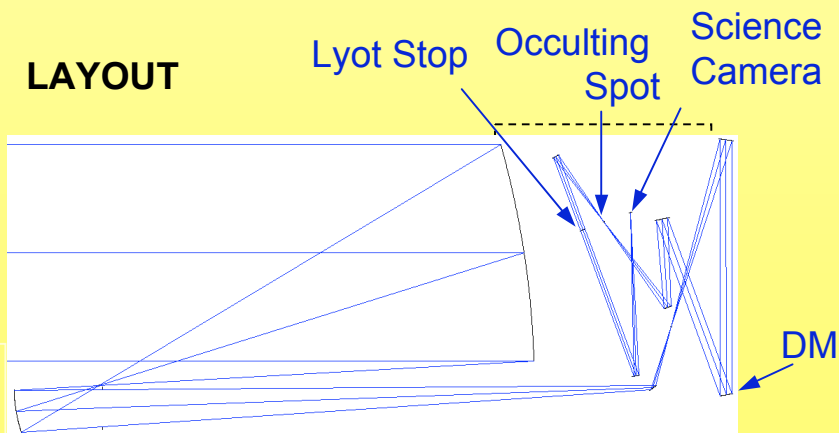


# TPF Coronagraph Description - Optics

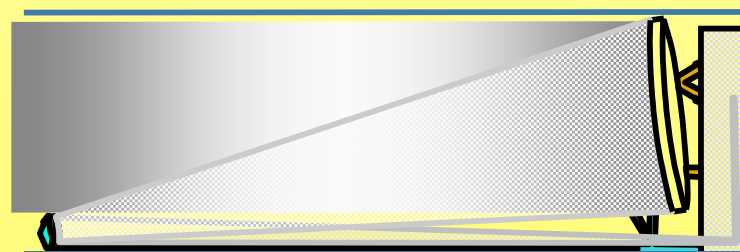
SCHEMATIC



LAYOUT



TPF-C TELESCOPE



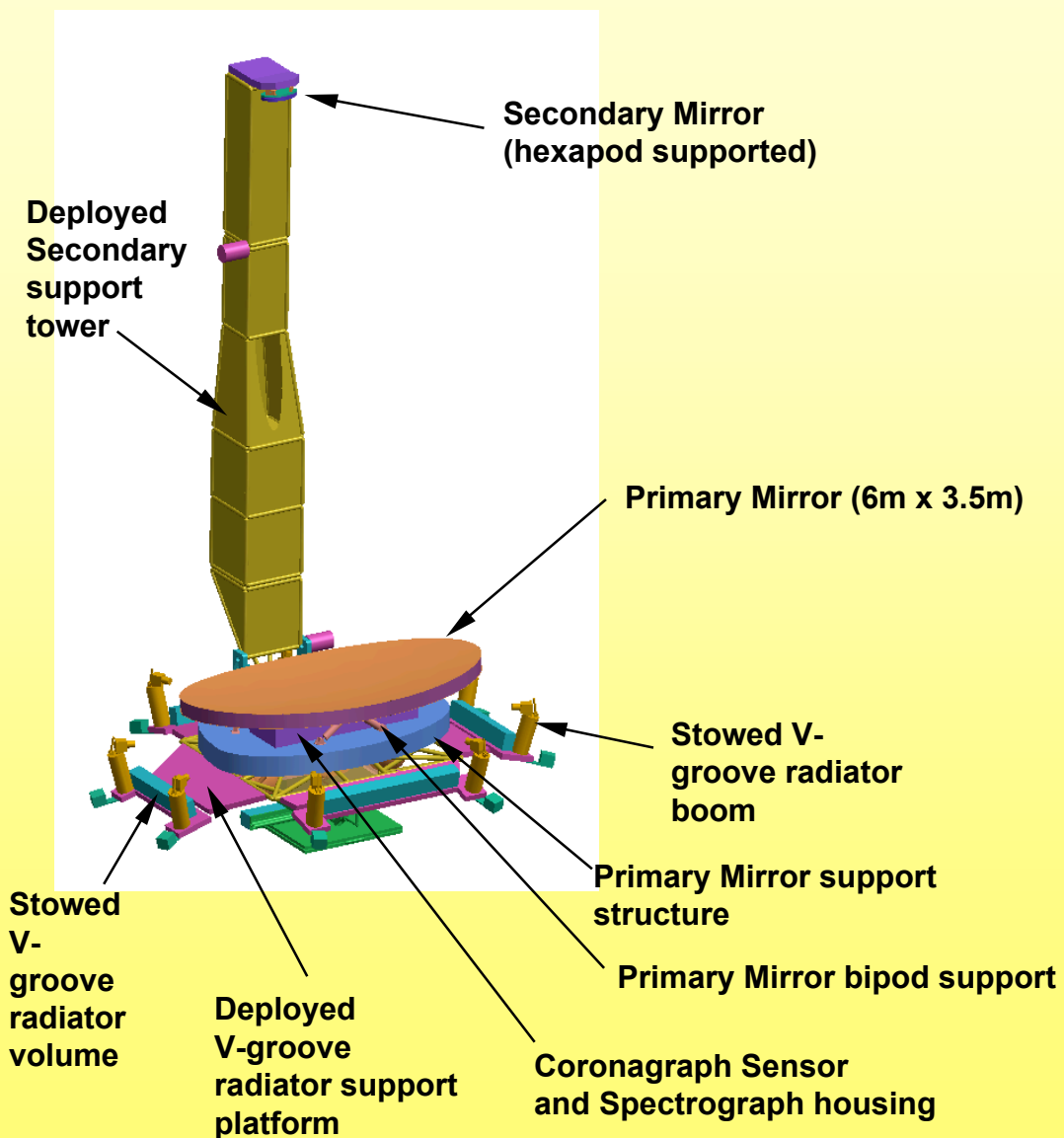
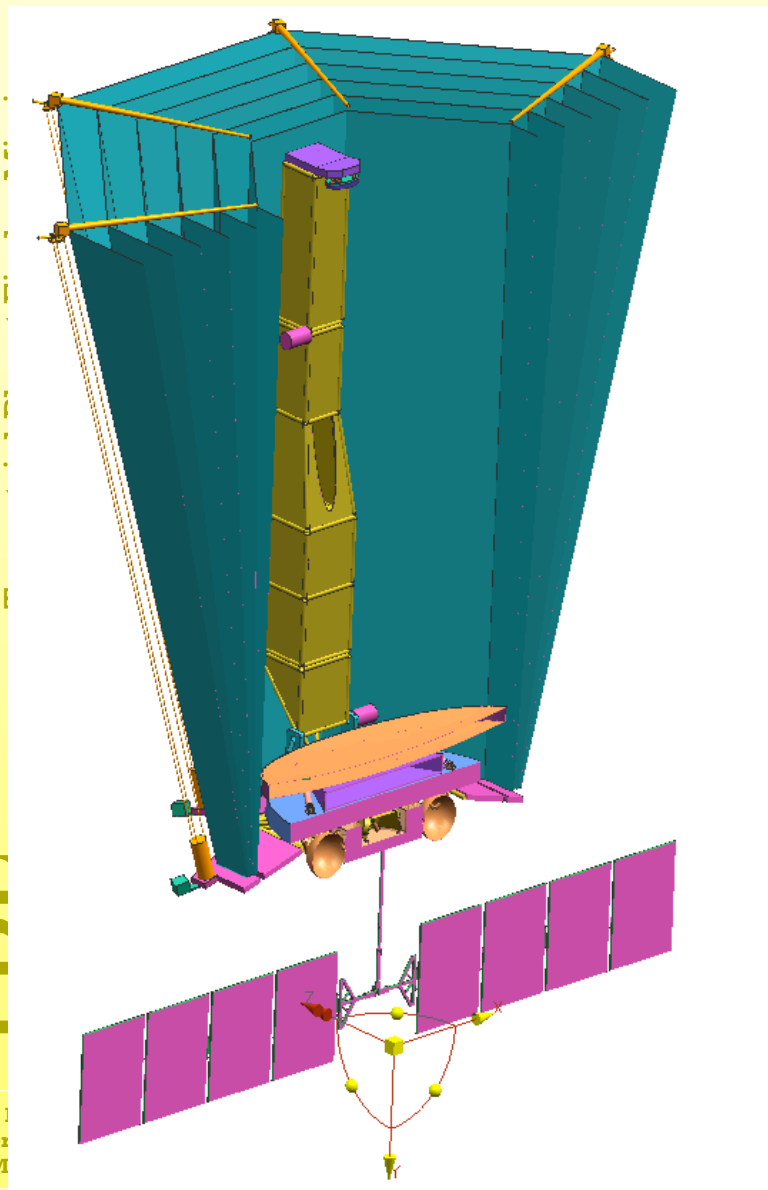
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# TPF Coronagraph Minimum Mission Conceptual Design





# Minimum Mission Requirements Flowdown



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Science Requirements	Derived Requirements	Engineering Choices	Wave Front Error Allocation		Derived Requirements	Tall Tent Poles
# Core Stars = 30			Static Errors = $1.6E-11$	WF Sensing/Control = $1.12E-11$	IFU Detection	6m Aperture
Core Star Type = F, G, K	Search Duration = TBD: star dependent OHZ period			Amplitude Uniformity = $1.5E-12$	Dual Polarization & coating uniformity	3 /D
Minimum Science Requirements	Visit Rate = TBD: star dependent IHZ			Mask Imperfections = $3.4E-12$	Precision Masks	Pol Splitting and uniform coatings
Search Completeness = 95%	IWA = 82 mas	IWA margin = 10%		Pointing error leakage = $6.4E-12$	Fine pointing = 1 mas	Mask Fab & Testing
HZ relative to Sun = .7 to 1.5 AU	Aperture Size = 6m at /D)	Angular Resolution	Dynamic Errors = $4.9E-11$	Dynamic effects Leakage = $2E-11$		90x90 DM
CHZ relative to Sun = .9 to 1.1 AU				Structural Deformation Beamwalk = $2.0E-12$	Optics power spectrum & allowed motion	Stiff structure
Wavelength Range = .5 to .8 $\mu$ m	DM Actuators = 90x90			Optics Deformation = $8.59E-12$	Stability = 1A PM, 1/4A SM, 1/16A small optics	Locking mechanisms
Detect Giant Planets - 5AU at 10 pc	OWA = 500 mas	Edge Roll Off Factor = 1.33		Structural Deformation Abberations = $9.38E-12$	PM - SM stability = 1nm	Active Isolation
Planet albedo = Earth	Wavefront error = $6.5E-11$			Rigid Body Beamwalk = $2.28E-12$	Rigid Body Pointing = 10mas	Thermal Controls
Planet size = Earth over HZ	Background error = $1.5E-11$			Thermal Effects leakage = $2E-11$	Optics Temp = 25 $\pm 3^\circ$ K	V-groove Thermal Shade
Planet size = 1/2 Earth over CHZ	Reserve = $2.0E-11$			Structural Deformation Beamwalk = $2.08E-12$	Optics Temp Stability = 1 m°K	Laser Metrology
Spectral resolution = 75	Search Mode integration time = 8 hrs	Q=1		Optics Deformation = $8.59E-12$	PM - SM stability = 1nm	
	Spectral Mode					

Terrestrial Planet Finder Coronagraph System

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# Tall Tent Poles

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Issue	Studies	Expo Information
Large Primary Mirror	TDM study	poster & presentation
Uniform Coatings	Kodak	presentation
Polarization	JPL, SWG	work in progress
Mask Fabrication & Testing	JPL lab and contracts	poster & presentation
90x90 DM	Xinetics, Boston Micromachines	presentation
	Architecture - error sensitivity	presentation
Structure Stiffness	DT & materials characterization	poster & presentation
Thermal Controls	Design Team modeling	poster & presentation
V-groove Thermal Shade	Design Team modeling	poster & presentation
Active Isolation	Industry	poster
Precision Mechanisms	JPL / Industry	yet to be investigated